

Unit 1:

1. What do you mean by internal treatment for water softening?

Internal treatment is the conditioning of impurities within the boiler system. The reactions occur either in the feed lines or in the boiler proper. Internal treatment may be used alone or in conjunction with external treatment.

2. Explain the disadvantages of hard water in domestic as well as industries.

Disadvantages of hard water in Domestic use :

This cause wastage of a lot of shops is used. Hard water does not lather freely with shop solution and produces sticky scum on the body. Thus, cleansing quality of soap is depressed and lots of water is wasted too.

Industrial use: (i) Textile industry: Hard water causes much of the soap (used in washing yarn, fabric etc.) to go as waste, because hard water cannot produce good quality of lather

3. Make use of Zeolite process how does hardness of water can be removed? Discuss its merits and demerits.

Hard water is passed inside a column filled with sodium-containing zeolites. Salts of calcium and magnesium are trapped by zeolites and sodium ions get released. This results in softening of water making water rich in sodium.

Merits of Zeolite Process:

- It removes the hardness almost completely (about 10 ppm hardness only).
- The process automatically adjust itself for variation in hardness of incoming water.
- This process does not involve any type of precipitation, thus, no problem of sludge formation occurs.

Demerits of Zeolite Process:

- The outgoing water (treated water) contains more sodium salts.
- This method only replaces Ca^{+2} and Mg^{+2} ions by Na^+ ions.
- High turbidity water cannot be softened efficiently by zeolite process.

4. Distinguish between temporary and permanent hardness. Briefly explain the draw backs of hardwater in domestic and industrial use.

Temporary hard water	Permanent
Presence of bicarbonates of calcium and magnesium, i.e. $\text{Ca}(\text{HCO}_3)_2$ and $\text{Mg}(\text{HCO}_3)_2$ makes the water, temporary hard water.	Presence of chlorides and sulfates of calcium and magnesium, i.e. CaCl_2 and MgSO_4 makes the water, permanent hard water.
It is called temporary hardness as it can be easily removed by simple boiling and filtering the water.	It is called permanent hardness as it cannot be removed by simple boiling and filtering the water.
It can be also called carbonate hardness.	It can be also called non-carbonate hardness.

. Disadvantages of hard water in Domestic use :

This cause wastage of a lot of soap is used. Hard water does not lather freely with soap solution and produces sticky scum on the body. Thus, cleansing quality of soap is depressed and lots of water is wasted too.

Industrial use: (i) Textile industry: Hard water causes much of the soap (used in washing yarn, fabric etc.) to go as waste, because hard water cannot produce good quality of lather.

5. Define the term BOD.

Biochemical oxygen demand (BOD) represents the amount of oxygen consumed by bacteria and other microorganisms while they decompose organic matter under aerobic (oxygen is present) conditions at a specified temperature.

6. Simplify boiler feed water and briefly describe about scale, sludge, foaming, and priming problems in boiler.

- A boiler is a device for generating steam • Consists of two main parts:
- Furnace and Boiler proper

*Furnace provides heat, usually by burning a fuel

* Boiler proper, a device in which the heat changes water into steam

- The steam or hot fluid is then recirculated out of the boiler for use in various processes in heating applications.

- Boiler receives feed water in the form of
 - Recovered condensed water (return water)

Sludge:

- Soft, loose and slimy precipitate formed within the boiler.
- Formed at comparatively colder portions of the boiler and are collected at the bends.
 - Formed by substances which have greater solubility in hot water than in cold water, e.g., MgCO_3 , MgCl_2 , CaCl_2 , MgSO_4 , etc
- Easily removed with wire brush
- Disadvantages of sludge formation
 - Sludges are poor conductors of heat, so they tend to waste a portion of heat generated.
 - Excessive sludge formation disturbs the working of the boiler.
 - Sludge can be removed by using
 - 1) Softened water
 - 2) by blow down operation i.e. drawing off a portion of the concentrated water.

Scales:

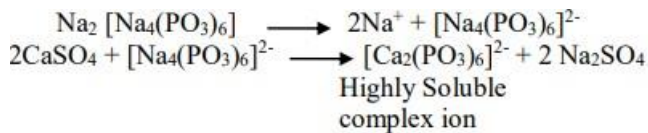
- Hard deposits firmly sticking to the inner walls of the boiler.
- Difficult to remove, even with the help of hammer & Chisel.

7. Define the term COD.

Chemical oxygen demand is the amount of oxygen needed to oxidize the organic matter present in water. Chemical oxygen demand testing is used to determine the amount of oxidation that will occur and the amount of organic matter in a water sample.

8. Solve the scaling problem with the help of Calgon conditioning method discuss it with suitable justification.

Calgon = sodium hexa meta phosphate The process involves the addition of calgon to boiler water. It prevents scale and sludge formation by forming highly soluble calcium hexa meta phosphate complex compound with CaSO_4 .



9. Distinguish between Zeolite softener and ion exchange process and its advantages and disadvantages.

Merits of ion-exchange process:

- The process can be used to soften highly acidic or alkaline water.
- It produces water of very low hardness (say 2ppm).
- It is very good for treating water for use in high-pressure boiler.

Demerits of ion-exchange process:

- The equipment is costly and more expensive chemicals are needed.
- If water contains turbidity, then the output of the process is reduced
- Turbidity must be below 10 ppm. If it is more, it has to be removed first by coagulation and filtration.

Merits of Zeolite Process:

- It removes the hardness almost completely (about 10 ppm hardness only).
- The process automatically adjust itself for variation in hardness of incoming water.
- This process does not involve any type of precipitation, thus, no problem of sludge formation occurs.

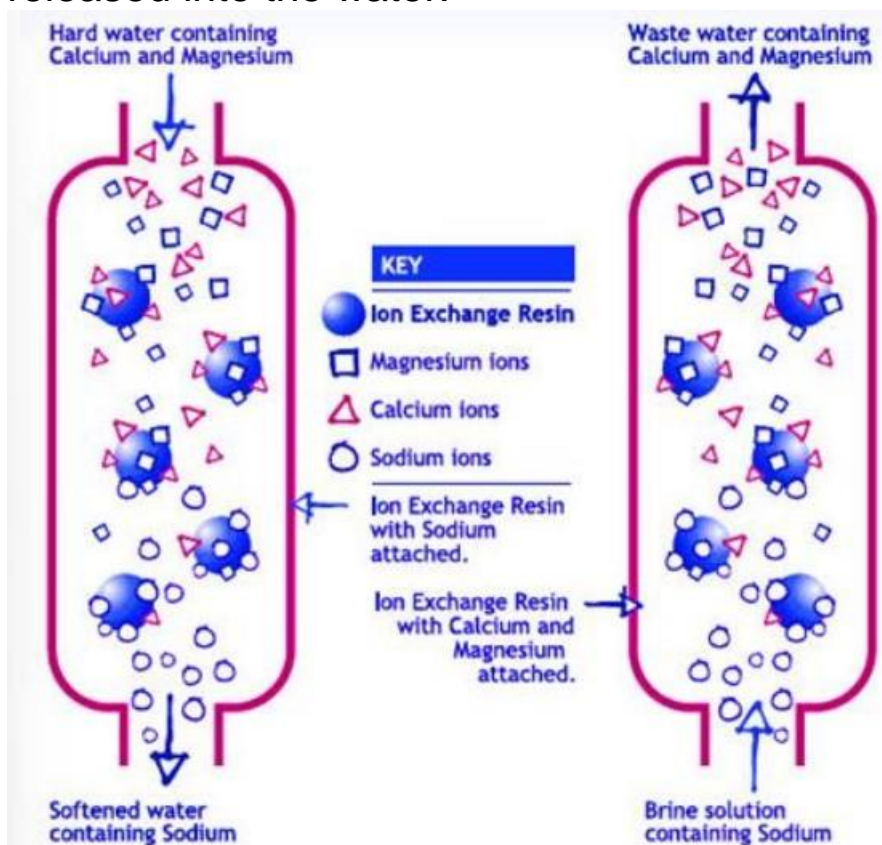
Demerits of Zeolite Process:

- The outgoing water (treated water) contains more sodium salts.
- This method only replaces Ca^{+2} and Mg^{+2} ions by Na^{+} ions.
- High turbidity water cannot be softened efficiently by zeolite process.

9th and 10th question are almost same

11. Identify how cation and anion exchange process used for the treatment of hard water. Mention its advantages and disadvantages.

As hard water passes through a softener, the calcium and magnesium trade places with sodium ions (**Figure 1**). Sodium ions are held loosely and are replaced easily by calcium and magnesium ions. During this process, “free” sodium ions are released into the water.



- **Advantages:**
- Selective removal is possible by choosing the right ion exchanger

- High removal efficiency is possible for cations and anions
- Regeneration of the bed gives a very long service life
(disadvantage of acid and base required = costs)
- Ion exchangers can also work well with low water pressure
- **Disadvantages:**
 - Sensitive to pollution, think, for example, of suspended particles
 - Resin can be sensitive for oxidizing substances
 - Cost of acids and bases for regeneration
 - Often a pre-purification step is needed such as aeration of the water, sedimentation and sand filtration.
 - Efficacy can be reduced due to fouling, by for example mineral scaling or surface clogging
 - Disposal costs of the acids and bases used for regeneration

Unit 2:

1. Inspect the waste in brief. Classify the waste according to their origin and type.

Waste is defined as unwanted and unusable materials and is regarded as a substance which is of no use.

Sources of waste can be broadly classified into four types: Industrial, Commercial, Domestic, and Agricultural.

Types of Waste

Commonly waste is classified into two types: Biodegradable and Non-biodegradable waste.

2. Identify the sanitary landfill for control of domestic waste.

A sanitary landfill is a pit with a protected bottom where trash is buried in layers and compressed to make it more solid. The main purpose of sanitary landfills is to ensure waste is safe by reducing the harm from accumulated waste and allowing safe decomposition.

3. Identify the process of incineration for controlling urban waste.

Incineration is a waste treatment process that involves the combustion of substances contained in waste materials.^[1] Industrial plants for waste incineration are commonly referred to as **waste-to-**

energy facilities. Incineration and other high-temperature waste treatment systems are described as "[thermal treatment](#)". Incineration of waste materials converts the waste into [ash](#), [flue gas](#) and heat. The ash is mostly formed by the [inorganic](#) constituents of the waste and may take the form of solid lumps or [particulates](#) carried by the flue gas. The flue gases must be cleaned of gaseous and particulate pollutants before they are dispersed into the [atmosphere](#). In some cases, the heat that is generated by incineration can be used to generate [electric power](#).

4. Identify the e-waste. Is e-waste hazardous, enumerate the different source of e-waste.

Electronic waste or **e-waste** describes discarded electrical or [electronic devices](#). Used electronics which are destined for refurbishment, reuse, resale, salvage recycling through material recovery, or disposal are also considered e-waste. Yes e-waste are hazardous for our health in many ways. like-electronic waste contains toxic components that are dangerous to human health, such as **mercury, lead, cadmium, polybrominated flame retardants, barium and lithium**. The negative health effects of these toxins on humans include brain, heart, liver, kidney and skeletal system damage.

5. Utilize the process of pyrolysis for controlling industrial waste.

Pyrolysis is the thermal decomposition of waste into gas and solid phases in the absence of the external oxygen/air supply. The process takes place under the temperatures typically around 500-600 °C. During pyrolysis plastic and tire breaks down into smaller molecules of pyrolysis oil, pyrolysis gas and carbon black.

6. Inspect the different constituents of e-waste. Why disposal of e-waste is necessary.

Constituent Materials of E-Waste and Problem Created By E-Waste:

- Precious metal like gold, platinum, silver and palladium.
- ADVERTISEMENTS:
- Useful metals like copper, aluminium iron etc.
- Hazardous material like mercury, radioactive isotopes.
- Toxic substances like dioxins, polychlorinated biphenyls (PCBs).

E-waste disposal is necessary because it contains lists of chemicals that are harmful to people and the environment, like: mercury, lead, beryllium, brominated flame retardants, and cadmium.

7. Simplify the biomedical waste. Discuss the different categories of biomedical waste and its disposal.

Biomedical waste (BMW) is any waste produced during the diagnosis, treatment, or immunization of human or animal research activities pertaining thereto or in the production or testing of biological or in health camps.

Types of Bio-medical waste

- Human anatomical waste like tissues, organs and body parts.
- Animal wastes generated during research from veterinary hospitals.
- Microbiology and biotechnology wastes.
- Waste sharps like hypodermic needles, syringes, scalpels and broken glass.
- Discarded medicines and cytotoxic drugs.

8. Organize the major impacts of solid waste on aquatic life.

if garbage is dumped into the ocean, the oxygen in the water could be depleted. This results in **poor health for marine life due to lack of oxygen**. Animals such as seals, dolphins, penguins, sharks and whales could die. most then die of starvation as their stomachs become filled with plastic. They also suffer from **lacerations, infections, reduced ability to swim, and internal injuries**.

9. Identify; how solid waste could be reduced and managed.

Solid waste can be reduced and managed by three principles: reduce, reuse and recycle

Reduce

- Take reusable bags to the grocery store instead of single-use plastic bags.
- Select items with limited or no packaging.
- Use a refillable container for water in place of bottled water.

Reuse

- Think of ways to use packaging materials and ways to reuse items that no longer serve their function.
- Use cloth napkins and plates instead of paper.

Reduce

- Take reusable bags to the grocery store instead of single-use plastic bags.
- Select items with limited or no packaging.
- Use a refillable container for water in place of bottled water.
- Think twice before printing material from the internet. When possible, print on both sides of the paper.
- Set a goal for reducing the amount of trash generated each week.

Recycle/Compost

- Make it a habit to separate out all items that are recyclable.
- Raise the cutting height of your lawn mower during the hot summer months to keep grass roots shaded and cooler. This reduces weed growth, browning, and the need for watering.

10. Explain the different techniques of waste disposal.

Landfill

In this process, the waste that cannot be reused or recycled are separated out and spread as a thin layer in low-lying areas across a city. A layer of soil is added after each layer of garbage. However, once this process is complete, the area is declared unfit for construction of buildings for the next 20 years. Instead, it can only be used as a playground or a park.

Incineration

Incineration is the process of controlled combustion of garbage to reduce it to incombustible matter such as ash and waste gas. The exhaust gases from this process may be toxic, hence it is treated before being released into the environment. This process reduces the volume of waste by 90 per cent and is

considered as one of the most hygienic methods of waste disposal. In some cases, the heat generated is used to produce electricity. However, some consider this process, not quite environmentally friendly due to the generation of greenhouse gases such as carbon dioxide and carbon monoxide.

Waste Compaction

The waste materials such as cans and plastic bottles are compacted into blocks and sent for recycling. This process prevents the oxidation of metals and reduces airspace need, thus making transportation and positioning easy.

Biogas Generation

Biodegradable waste, such as food items, animal waste or organic industrial waste from food packaging industries are sent to bio-degradation plants. In bio-degradation plants, they are converted to biogas by degradation with the help of bacteria, fungi, or other microbes. Here, the organic matter serves as food for the micro-organisms. The degradation can happen aerobically (with oxygen) or anaerobically (without oxygen). Biogas is generated as a result of this process, which is used as fuel, and the residue is used as manure.

Composting

All organic materials decompose with time. Food scraps, yard waste, etc., make up for one of the major organic wastes we throw every day. The process of composting starts with these organic wastes being buried under layers of soil and then, are left to decay under the action of microorganisms such as bacteria and fungi.

This results in the formation of nutrient-rich manure. Also, this process ensures that the nutrients are replenished in the soil. Besides enriching the soil, composting also increases the water retention capacity. In agriculture, it is the best alternative to chemical fertilizers.

Vermicomposting

Vermicomposting is the process of using worms for the degradation of organic matter into nutrient-rich manure. Worms consume and digest the organic matter. The by-products of digestion which are excreted out by the worms make the soil nutrient-rich, thus enhancing the growth of bacteria and fungi. It is also far more effective than traditional composting.

11. Illustrate the various consequences associated with solid waste.

Some of the catastrophic effects of today's poor waste management systems are listed below:

- Soil Contamination. ...
- Water Contamination. ...
- Extreme Weather Caused By Climate Change. ...
- Air Contamination. ...
- Harm Towards Animal and Marine Life. ...
- Human Damage